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EXAMINER

NGUYEN, DILINH P

ART UNIT

PAPER NUMBER

2814

DATE MAILED: 09/22/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/645,308

Applicant(s)

KUMAR ET AL.

Examiner

DiLinh Nguyen

Art Unit

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 05 July 2005.
- 2a) ☒ This action is **FINAL**. 2b) ☐ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-14 and 16-31 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-14 and 16-31 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on _____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
 2. ☐ Certified copies of the priority documents have been received in Application No. _____.
 3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413) Paper No(s)/Mail Date. _____ |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____ | 6) <input type="checkbox"/> Other: _____ |

DETAILED ACTION

Claim Rejections - 35 USC § 103

1. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

2. Claims 1-14 and 16-31 are rejected under 35 U.S.C. 103(a) as being unpatentable over Ngo et al. (U.S. Pat. 6723635) in view of Goh et al. (U.S. Pat. 6797605).

- Regarding claims 1 and 9, Ngo et al. disclose a dual damascene interconnect structure, comprising :
 - a patterned multilayer of dielectrics on a substrate, comprising:
 - a cap layer 12;
 - a via level low-k dielectric layer 13 having thereon metal via conductors with a bottom portion and sidewalls;
 - an etch stop layer 14;
 - a first porous low-k line level dielectric layer 15 (silicon nitride or silicon oxynitride) having thereon metal line conductors with a bottom portion and sidewalls;
 - a polish stop layer 43 over the low-k dielectric 13;
 - a thin non-porous low-k dielectric layer 20A (silicon carbide) for coating and planarizing the line and via sidewalls; and

a liner material 40 between the metal via and line conductors and the dielectric layers;

wherein the thin non-porous low-k dielectric layer 20A has a composition (silicon carbide) that is covalently bonded with the via level low -k dielectric layer 13 and a first porous low-k line level dielectric layer 15 (cover fig.).

Ngo et al. do not disclose a first non-porous via level low-k dielectric layer.

However, Goh et al. disclose dual damascene inter connect structure, comprising: a non-porous via level low-k dielectric layer 18 (organic) having thereon metal via conductors with a bottom portion and sidewalls (cover fig., column 2, lines 65 et seq.). Therefore, it would have been obvious to one having ordinary skill in the art at the time the invention was made to substitute the via level low-k dielectric layer of Ngo et al. by a non-porous via level low-k dielectric layer, as taught by Goh et al., in order to improve adhesion of dielectric films in damascene interconnects (abstract).

- Regarding claim 2, Goh et al. disclose the porous 24 and the non-porous low-k dielectric layers form covalent bonds with the etch stop layer 22 (cover fig.).
- Regarding claim 3, Goh et al. disclose that the non-porous low-k dielectric layer 18 has a material that is covalently bound to the etch stop layer 22 (cover fig.).
- Regarding claim 4, Goh et al. disclose that the covalently bound material is selected from the group consisting of: SILKTM, GX-3TM, organic material and a combination thereof (cover fig., claim 1).
- Regarding claim 5, Ngo et al. disclose that the first porous low-k dielectric layer 15 has a material that is covalently bound to the etchstop layer 14 (cover fig.).

- Regarding claim 6, Ngo et al. disclose that the first porous low-k dielectric layer has a material selected from the group consisting of: SILK™, GX-3™, porous organic material and a combination thereof (cover fig., column 5, lines 7-20).
- Regarding claim 7, it would have been obvious to form the pores of Ngo et al. with a pore size greater than 2 nm. Moreover, the pore size would have been obvious to an ordinary artisan practicing the invention because, absent evidence of disclosure of criticality for the range giving unexpected results, it is not inventive to discover optimal or workable ranges by routine experimentation. *In re Aller*, 220 F.2d 454, 105 USPQ 233, 235 (CCPA 1955). Furthermore, the specification contains no disclosure of either the critical nature of the claimed dimensions of any unexpected results arising therefrom. Where patentability is aid to be based upon particular chosen dimensions or upon another variable recited in a claim, the Applicant must show that the chosen dimensions are critical. See *In re Woodruff*, 919 F.2d 1575, 1578, 16 USPQ2d 1934, 1936 (Fed, Cir. 1990).
- Regarding claim 8, Goh et al. disclose the non-porous low k dielectric and the porous low k dielectric layers have identical chemical compositions (cover fig., claim 5).
- Regarding claim 10, Ngo et al. disclose that the etch stop layer 14 and the thin non-porous low k dielectric layer are silicon containing (cover fig., column 5, lines 39-47).

- Regarding claim 11, Ngo et al. disclose that the etch stop layer 14 is silicon containing (cover fig., column 5, lines 39-40).
- Regarding claim 13, Ngo et al. disclose that the thin non-porous low k dielectric layer has the same chemical composition as the etch stop layer (cover fig.).
- Regarding claim 14, Ngo et al. disclose that the thin non-porous dielectric layer has a thickness of about 20 angstroms to about 100 angstroms (column 5, lines 45-46).
- Regarding claims 12 and 16, Ngo et al. disclose that the thin non porous low k dielectric layer 20A is selected from the group consisting of silicon carbides (cover fig., column 5, line 46) and it would have been obvious to form the first non porous low k layer consisting of silicon carbides.
- Regarding claim 17, Ngo et al. disclose that the thin non-porous low k dielectric layer 20A conformally coats the line and via sidewalls (cover fig.).
- Regarding claim 18, Goh et al. disclose that the porous low k dielectric layer has a thickness of about 600 Angstroms to about 5000 angstroms (cover fig., claim 6).
- Regarding claims 19 and 21-22, Goh et al. disclose that the etch stop layer 22 has a chemical composition comprising silicon, oxygen (cover fig., column 3, lines 40-41); the etch stop layer is selected from the group consisting of: silicon oxides (column 3, lines 40-41) and wherein the etch stop layer has a thickness of about 50 angstroms to about 600 angstroms (column 3, lines 38-39).

- Regarding claims 20 and 24, Ngo et al. disclose that the etch stop layer 14, wherein the etch stop layer is obviously comprised of a spin on material with etch selectivity to the porous low k dielectric; the liner material 40 and it would have been obvious to form the liner material is a material deposited by sputter deposition, PVD, CVD. Initially, and with respect to claims 20 and 24, note that a “product by process” claim is directed to the product per se, no matter how actually made. See In re Thorpe et al., 227 USPQ 964 (CAFC, 1985) and the related case law cited therein which makes it clear that it is the final product *per se* which must be determined in a “product by process” claim, and not the patentability of the process, and that, as here, an old or obvious product produced by a new method is not patentable as a product, whether claimed in “product by process” claims or not. As stated in Thorpe,

Even though product-by-process claims are limited by and defined by the process, determination of patentability is based on the product itself, *In re Brown*, 459 F.2d 531, 535, 173 USPQ 685, 688 (CCPA 1972); *In re Pilkington*, 411 F.2d 1345, 1348, 162 USPQ 145, 147 (CCPA 1969); *Buono v. Yankee Maid Dress Corp.*, 77 F. 2d 274, 279. 26 USPQ 57, 61 (2d. Cir, 1935).

- Regarding claim 23, Ngo et al. disclose that the liner material 40 comprises one or more metals selected from the group consisting of tantalum nitride (cover fig. column 5, lines 58-59).

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- Regarding claim 25, Ngo et al. disclose that the liner material 40 is continuous and does not penetrate into the porous dielectric (cover fig.).
- Regarding claim 26, Ngo et al. disclose that the liner material 40 has a sharp planar interface to the dielectric layers (cover fig.).
- Regarding claim 27, Goh et al. disclose that the metal conductor 36 is a patterned metal conductor comprising a metal selected from the group consisting of copper (cover fig., column 4, lines 58-60).
- Regarding claim 28, Goh et al. disclose that at least one of the patterned metal conductors is an electrical via (cover fig.).
- Regarding claim 29, Goh et al. disclose that at least one of the patterned metal conductors is a line connected to the via (cover fig.).
- Regarding claim 30, Goh et al. disclose that the non-porous low k dielectric layer 18 has a metal via formed therein (cover fig.).
- Regarding claim 31, Goh et al. disclose that the porous low k dielectric layer 24 has a metal line formed therein (cover fig.).

Response to Arguments

Applicant's arguments filed 7/5/05 have been fully considered but they are not persuasive.

- The Applicant argues that Ngo does not disclose the second thin non-porous low-k dielectric layer has a composition that is covalently bonded with either dielectric layer 13 or 15 for enhanced adhesion as recited in claim 1.

The argument has been fully considered but they are not persuasive because Ngo et al. clearly disclose that a thin non-porous low-k dielectric layer 20A for coating and planarizing the line and via sidewalls; wherein the thin non-porous low-k dielectric layer 20A is selected from the group consisting of silicon carbides and positioned between a via level low-k dielectric layer 13 and a first porous low-k line level dielectric layer 15. Therefore, the non-porous silicon carbides layer 20A is covalently bonded with the low-k dielectric layer 13 and the first porous low-k line level dielectric layer 15 for enhanced adhesion as recited in claim 1.

- The Applicant argues that Goh does not disclose providing a thin non-porous dielectric layer that is covalently bonded with a first dielectric layer and a second dielectric layer.

It should be noted that the rejection of claims 1-14 and 16-31 are not based on anticipation, but rather, is based on obviousness. Examiner relies on the combined teachings at Ngo et al. and Goh et al.. Goh et al. is not relied on for teaching the thin non-porous low-k dielectric layer for coating and planarizing the line and via sidewalls. Goh et al. is only relied on for showing the non-porous via level low-k dielectric layer having thereon metal via conductors with a bottom portion and sidewalls. The Examiner thus regards the Applicant's assertions as constituting evidence that the Applicant has failed to considered as a whole the prior art teachings disclosed by the combining of the references.

Conclusion

THIS ACTION IS MADE FINAL. Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire **THREE MONTHS** from the mailing date of this action. In the event a first reply is filed within **TWO MONTHS** of the mailing date of this final action and the advisory action is not mailed until after the end of the **THREE-MONTH** shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than **SIX MONTHS** from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to DiLinh Nguyen whose telephone number is (571) 272-1712. The examiner can normally be reached on 8:00AM - 6:00PM (M-F).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Wael Fahmy can be reached on (571) 272-1705. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

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Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

DLN



HOAI PHAM
PRIMARY EXAMINER